

7 Defining vector valued functions

Like in section 5, we describe how to create a handle to an anonymous function: let $\mathbf{f}(t, \mathbf{y}) = \mathbf{A}\mathbf{y} + \mathbf{b}$, with $\mathbf{A} = \begin{pmatrix} -0.5 & 1 \\ -1 & -0.5 \end{pmatrix}$ and $\mathbf{b} = (1, 2)^T$. In matlab, this looks like

```
f = @(t,y) [ -0.5.*y(1)+y(2)+1 ; -y(1)-0.5.*y(2)+2 ];
```

Note the “.*”! The “;” produces a column vector, which is what we need for `ode45`.

8 Solving IVP for systems of ODE

The goal is the same as in section 6, just that now y and $f(t, y)$ are vectors. Thus, equation (6.1) becomes

$$\begin{pmatrix} y_1' \\ \vdots \\ y_n' \end{pmatrix} = \begin{pmatrix} f_1(t, \mathbf{y}) \\ \vdots \\ f_n(t, \mathbf{y}) \end{pmatrix} \quad \begin{pmatrix} y_1(0) \\ \vdots \\ y_n(0) \end{pmatrix} = \begin{pmatrix} y_1^0 \\ \vdots \\ y_n^0 \end{pmatrix} \quad (8.1)$$

Here an example for the system

$$\begin{pmatrix} y_1' \\ y_2' \end{pmatrix} = \begin{pmatrix} -\frac{1}{2} & 1 \\ -1 & -\frac{1}{2} \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} + \begin{pmatrix} 1 \\ 2 \end{pmatrix} \quad \mathbf{y}_0 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

In matlab, we can solve this by

```
f = @(t,y) [ -0.5.*y(1)+y(2)+1 ; -y(1)-0.5.*y(2)+2 ];
```

```
[t,y] = ode45(f, [0 10], [1 0]);
```

```
plot (y(:,1), y(:,2));
```

In order to plot a phase portrait, you could add the following lines

```
hold on;
```

```
[t,y] = ode45(f, [0 10], [2 1]);
```

```
plot (y(:,1), y(:,2));
```

```
[t,y] = ode45(f, [0 10], [3 0]);
```

```
plot (y(:,1), y(:,2));
```

```
[t,y] = ode45(f, [0 10], [2 -1]);
```

```
plot (y(:,1), y(:,2));
```